

# A new iterative cut and adaptive coordinate transform method for fast page outline detection and dewarping

Fengjun Guo, Yadong Li, Pengwei Li 2019 Sept.

AIM, IntSig Corporation www.ccint.com



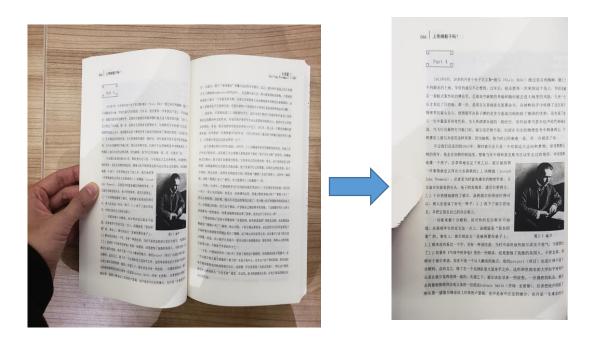






#### Motivation & Design principle

- Digitize physical books to pdf
  - Detect and segment book pages
  - Dewarping and reconstruct a high-quality image to improve readability
  - Improve OCR accuracy
- Design Principle
  - Low computation consumption
  - Robust





#### Workflow of our system



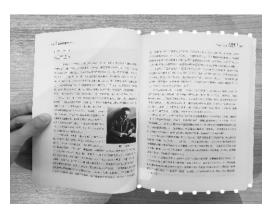




Input

Page split

Page left-right outline





400 主用框架 7659 4) 4100 4100 to 8 - 8. 41414 (416) \$100 8200 \$10. 4(16) \$4 + 16) \$10 16 erren expeliere, errecte per erren e 机多定电路等级的运动系统 医四种素、电动物的电路 第二次 形成功能体 和协议会,并不是为时间的时间来,都没有许多的形式。 the Browner . Lie Destrict a del trappe of · 中华科斯提供为现象,就预求的海流的利益。 ·明点还要得了好物 孩子。由于收车者提供 道。在演教学生的论文这一点上,后被决定"器会位 首"的。哪是生,被急的伦发一直被引要你保护生。 医眼体设施管理 不完,将在一种描述是。当时不通识处的技术也实不在"生" 10. 的著位《代文》的学生》包括一些诗话。 给果是读了高度的英语人。所 自動物,也可以此,但是在一个定理的技术设计可也为,此用中也许分别,大学 为是世界长安阳四年·省外、为安全 5、校园的农业会 电) 成功。 4万级被打开





产生了神秘的chemistry(化学反应),在促酶长衰之后,两人都坚持相关性晚。产慧福很 和资价了被以一个实验室的名词。但是公伙员物建立于与提出来自创新启行基础影响。这 接工业城市的天空虽然污染。但是内部特+产禁锢的名字即使它看起来都将地全化闪耀。 说起来, 产至极也是几丁汤姆逊的学生, 这位出身于最高工术场的科学家身上保持 者女性部動位朴实的作风。对他的助于和学生们永远是那样易情和关心。提供所有力所能 及的样动、再说。被尔达祥的时机真是再恰当不过了。1912年,那正是一个整样的曝光就 这个故事还要从19世纪说起、1897年、1.1.汤姨要在研究架模划线的时候、发现了原 子中电子的存在。这打破了从古希腊人斯里流传下来的"私子不可分割"的理念。明确地 的呢! 汤姆逊那时完全缺乏实验证据, 他于是展开自己的想象。勾勒出这样的报道: 至于 星球状、带正电荷、连带负电荷的电子划一粒粒料"镰骨"在这个圆束上。这样的一幅折 《粒子《带正电的架核》来表而一张极薄的金箔,想通过数射来确认那个"葡萄干布丁" 的大小和性膜。这时候,极为不可思议的情况出现了。有少数。粒子的很耐角度是如此之 价地弹向一张纸套出。 结果这种模型被反映了回来,反而由中了你自己一样"。 产等模型码了要是土多德的星"开爱开朗,但在更要真理"的优杂品格、决定物改活 舞进的"葡萄干布丁"模型、他认识到、《粒子被反弹回来、必定是因为它们和全部原子 分质量。但是、从 9 粒子只有限 9 一部分出现大角度散射这一情况来看,那些心占相的地 方是核小的。不到脑子半移的万分之 于是、产基础在次年(1911年)发表了他的这个新模型。在他基础的原子报像中、有 一个占据了他大部分规律的"联子根"在联子的中心、而在这个原子核的范围。专负电的 电子则沿着转定的轨道绕着它运行。这碳像一个行起系统(比如太阳系),所以这个核型 被传乐 与核地称为"行星系统"模型。在这里、原子核就像是太阳。而电子则是原境太阳

Page top-bottom outline

**Text-line detection** Fig. 1.

**Dewarping and finger-removing** 



## Page Outline Detection

#### Pipeline of book outline detection

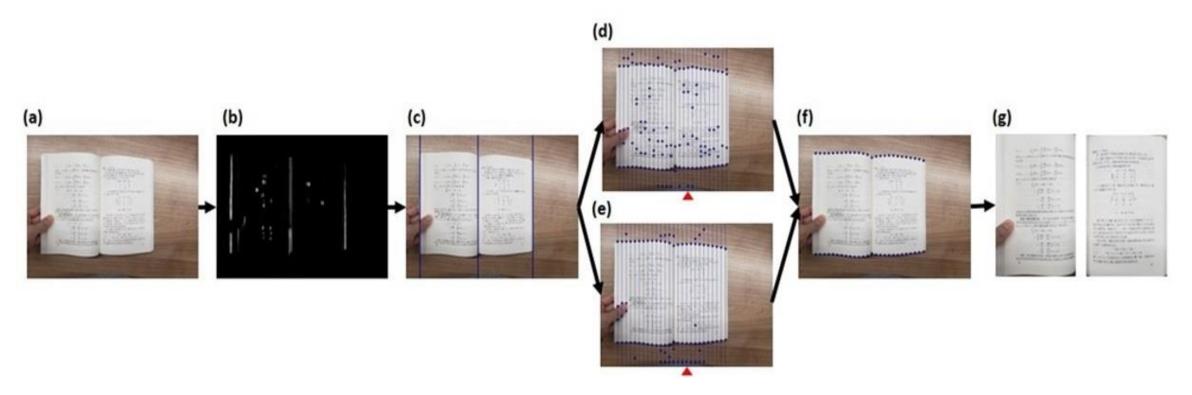
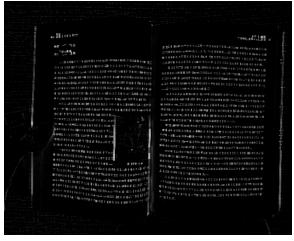


Fig. 2. (a) original image, (b) horizontal gradient map, (c) left and right boundaries detected by Hough transform, (d) and (e) calculated transition points on the brightness channel and saturation channel, respectively, (f) top and bottom outline, and (g) cropped pages using corner points.

## Left-right outline detection









Input image

Vertical gradient map

Opening operator

Hough line detection for left/right boundary



#### Top-bottom outline detection –Transition points detection

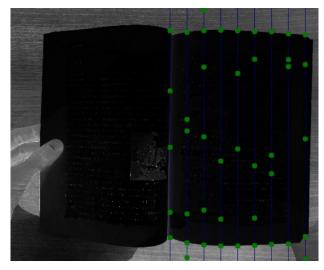


Fig. 3. Detected transition points overlaid on saturation channel

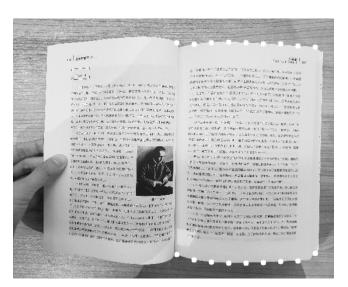


Fig. 4. Detected top/bottom boundary

- Uniform sample column pixels (blue lines in Fig. 3).
- Detecting transition points on each column pixels on saturation/brightness channel (maximize inter-class variation), respectively (points in Fig. 3).
- Horizontally linking transition points based on vertical distance and vertical gradient magnitude
- Selecting the longest link as top/bottom boundary (bright points on Fig. 4)

#### Outline detection – advantage & principle

- Low computation consumption
- Robust
  - Robustness in a complex background
  - Detect curving page outline

### Dewarping methods

#### Adaptive Dewarping method

- Hybrid method
  - **■** General Coordinate Transform Model(GCTM)
  - **Optimization-based dewarping method (ODM)**

Method selection based on top-bottom curve layout

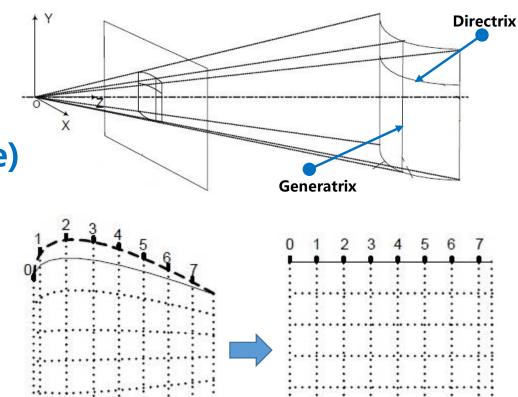


### General Coordinate Transform Model(GCTM)

Models the page as a cylinder surface

 Mapping between directrix is a linear transformation( Generatrix same)

 Use top/bottom text line and their scaling relationship to dewarp whole page



#### Reference:

1 H. Cao, X. Ding, and C. Liu, "Rectifying the bound document image captured by the camera: A model based approach," in Proceedings of the 2003 Seventh International Conference on Document Analysis and Recognition, 2003, pp. 71-75: IEEE.



## Optimization-based dewarping method (ODM)

- Model the elevation of page as a polynomial
- Optimize the parameters

By minimizing the mapping error between straight textline and warped textline.

Advantage

Avoid significant artificial distortion (based on all text-lines of image)

Disadvantage

May fall into local minimization, leading to dewarping-effect is not obvious.

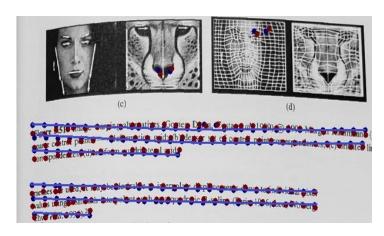


Fig. 5. Optimization procedure makes the straight blue line on top of red curved text line.

#### **ACTM Dewarping method**

Switch dewarping method based on top-bottom curve layout

#### Switch logic

```
if( distance between the top and bottom curves > image height *
alpha )
    Implement GCTM;
else
    Implement ODM;
```

*Note: alpha [0.4 ~ 0.5]* 

#### Dewarping Refinement

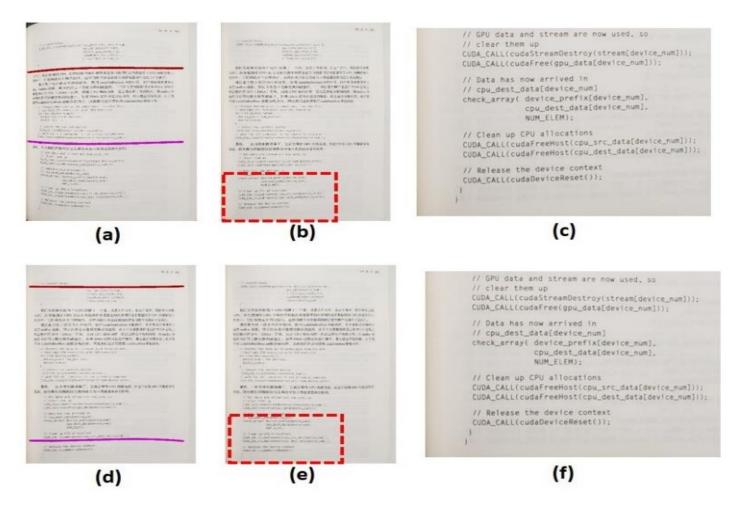


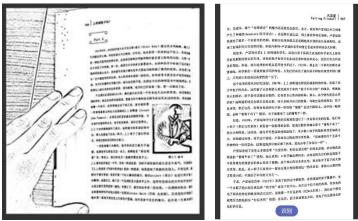
Fig. 6. Coarse-refinement dewarping procedure. The top panel shows results of the coarse dewarping procedure and the bottom panel shows results of the refinement dewarping procedure.

(a, d) detected top and bottom curves, (b, e) dewarped image, and (c, f) enlarged images of the insets in the dashed rectangle.

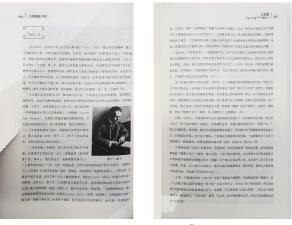
#### Result compare (1)



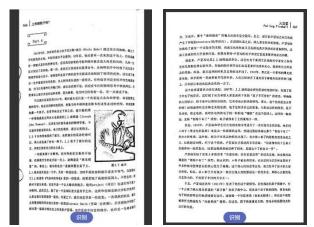
#### Input



Abbyy output(1)



#### **Our Result**



**Abbyy output (2)** 



#### Result compare (2)

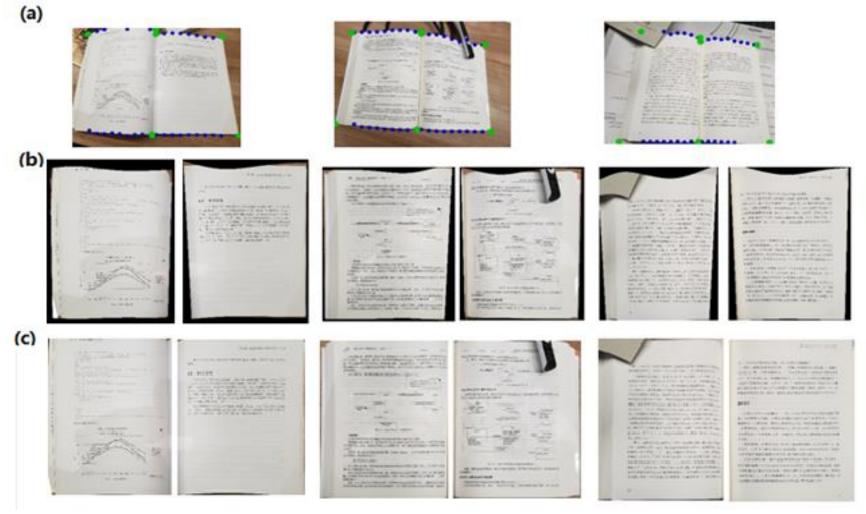
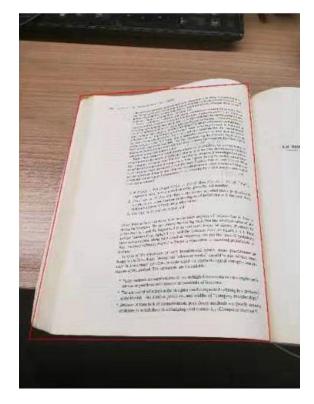


Fig. 7. Page outline detection and dewarping results on our dataset. Upper panel

- (a): detected page up-bottom boundary (blue dots) and page corner points on original image (green dots). Middle panel
- (b): dewarping results obtained using Kil's method
- (c): dewarping results obtained using ACTM.

#### One page cropping and dewarping



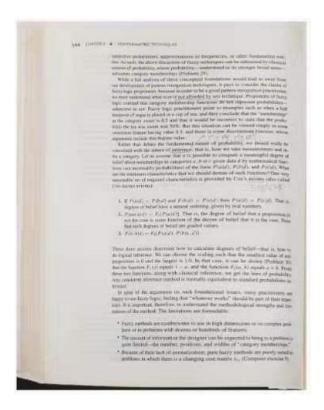


Fig. 8. One-page cropping & dewarping

#### Conclustion

#### Method

- Fast page outline detection
- Hybrid dewarping system
- Advantage
  - Low resource requirement
  - Robustly detect page outlines in complex background
  - Handle various layouts

	Kil's method [2]	ACTM
Time on Intel Core i7 (ms)	1200 - 3000	200
Time on Phone with Snapdragon 845 (ms)	/	600

	Original	Kil's method	ACTM
OCR Accuracy	80.7%	93.4%	93.2%





CCi 合合信息

CamerScaner book model UI & Video

2 T. Kil, W. Seo, H. I. Koo, and N. I. Cho, "Robust document image dewarping method using text-lines and line segments," in 2017 14th IA Document Analysis and Recognition (ICDAR), 2017, vol. 1, pp. 865-870: IEEE

## **Thanks**